Canaveral Barge Canal
Water Quality Monitoring
2009 Annual Report

for the

Canaveral Port Authority

by

Safety & Environmental Assessment Services, Inc.

EXECUTIVE SUMMARY

Safety & Environmental Assessment Services, Inc. (SEAS) has been sampling the Canaveral Barge Canal since 2003. This water quality report summarizes the data collected in 2009. This year monitoring continues a program which has been ongoing without a break since August of 1993.

The 2009 sampling began in January of this year. There are six stations in the Barge Canal monitoring programs. Four stations are located in the main canal from the confluence with the Indian River Lagoon eastward to the confluence with the Banana River Lagoon. One station is located in each confluence with Sykes Creek. All samples were collected by SEAS personnel and returned to contract laboratories for chemical and bacteriological analyses.

A review of the data collected in 2009 indicates that the Canaveral Barge Canal generally met the criteria for its designation as a Class III Predominately marine water body by 62-302 Florida Administrative Code (FAC). Class III marine waters are designated for recreation, propagation and maintenance of a healthy, well balanced population of fish and wildlife. There were some water quality violations and some indications of chemical stress to the system in 2009. Additionally the TMDL (total maximum daily load) average values for Chlorophyll_ a are at levels that indicate impairment. Specifically this year's data indicates the following:

• **Dissolved Oxygen:**

There were violations of the state standard for dissolved oxygen (DO) in marine waters of 4.0 parts per million (ppm) at all stations in May, June, August and September. Average DO at all stations meet or exceed State standards ranging from 4.5 to 5.9 mg/L. Biochemical Oxygen Demand was generally low throughout the canal although total Organic Carbon continues to be high. We will continue to watch these parameters closely in 2010

• **Nutrients:**

(Nitrogen and Phosphorus):Total Phosphorus and Total Nitrogen values were within acceptable ranges this year.

• **Chlorophyll-*a*:**

Chlorophyll-a average values have risen throughout the canal this year with the annual mean for all stations exceeding 11ug/L which is the is the TMDL limit set by EPA and DEP .

• **Bacteriological**:

There were no violations of the state standard for Fecal Coliform in the Barge Canal in 2009.

• **Metals**:

There were two violations of the state standard for Mercury in March of 2009. These stations were re-sampled in May and were found to be below detection limits. No violations were found during subsequent sampling. All other metals values were below state standards.

• **Oil and Grease**:

For the past five years all samples for oil and grease were below the state standard of 5 ppm at all stations.

Introduction

Water quality is a primary concern of the people of Florida. All coastal waters in Brevard County are classified as Class III waters "for recreation, propagation and maintenance of a healthy, well balanced population of fish and wildlife" or higher. The Canaveral Barge Canal is an important commercial and recreational waterway connecting Port Canaveral, through the Banana River Lagoon to the Indian River Lagoon and the Intercoastal Waterway. It is used and enjoyed by millions of people each year and is a Class III, predominantly marine waterbody. As such, the water quality of the Barge canal is of interest to governmental agencies, environmental groups and private interests alike. The Canaveral Port Authority (CPA) is committed to maintaining excellent water quality of all surface waters under its control.

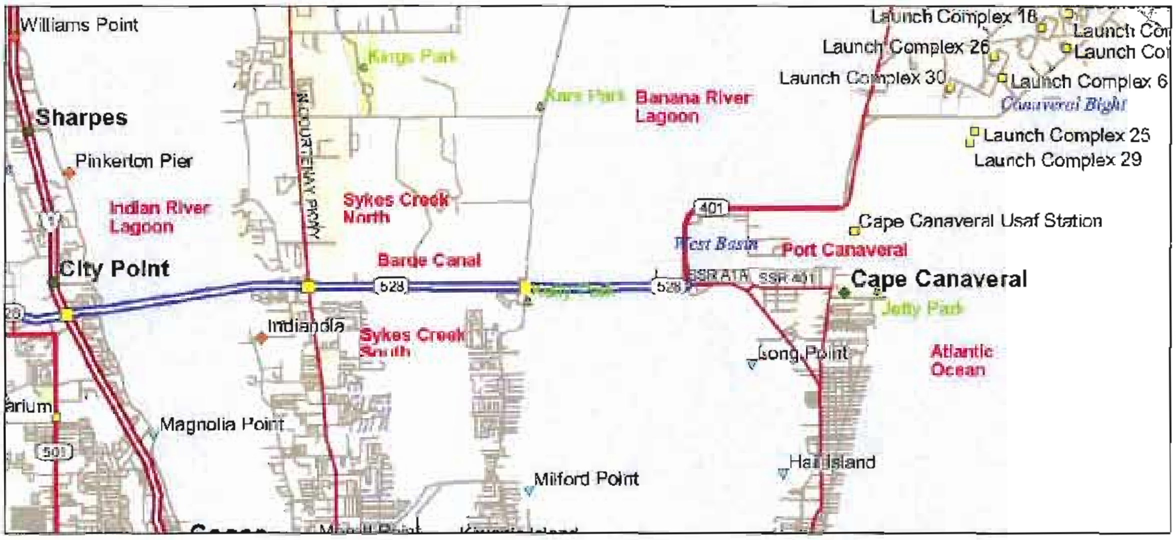
Water quality monitoring in the Canaveral Barge Canal has been conducted by the Florida Department of Environmental Regulation (now the Department of Environmental Protection, Brevard, County and the St. Johns River Water Management District for many years. The Canaveral Port Authority began sampling the Barge Canal in the 1980s under a contract with Sheffield Engineering & Associates. This program, consisted of 5 surface water stations sampled monthly. This program with one additional station continues without a break in monitoring through the present time.

In 2002, Safety & Environmental Assessment Services, Inc. (SEAS) was contracted to continue water quality monitoring of the Barge Canal. SEAS personnel collected all samples, conducted in-situ field measurements, contracted analyses of samples, evaluated water quality data and produced reports to the CPA. SEAS began sampling 6 stations in the Barge Canal in January, 2003.

The multi purpose of Water Quality monitoring is to:

- Ensure good water quality is maintained in the Barge Canal
- Document and discuss water quality data in 2009.
- Documented chemical and bacteriological characteristics of the study area.
- Provided background data in areas that have not been recently sampled.
- Determine short and long term water quality trends.
- Locate water quality problem areas due to development, point source and non-point source discharges.
- Provide a series of data reports to be used in decision making and Property development along the shores of the Barge Canal.
- Recommend suggestion for future monitoring in the Canaveral Barge Canal.

Location and physical description of the sampling area



The Canaveral Barge Canal is a man-made access canal cut through Merritt Island which connects the Banana River Lagoon with the Indian River Lagoon. Boat Traffic can access Port Canaveral and the Atlantic Ocean from the Intercoastal waterway by way of the Canaveral Barge Canal. Although the bottom land beneath the canal is not State owned sovereign submerged lands, the water in the canal is classified as Class III marine waters by the Florida Administrative Code.

The canal is approximately 18,000 feet in length and approximately 200 feet wide. Its average depth is 14 feet. The canal is used by oil barges carrying fuel oil to two major power generating plants on the western shore of the Indian River Lagoon. The canal is also used extensively by recreational and commercial boaters due to its convenient location and access to the Atlantic Ocean. It provides the only ocean access between Ponce De Leon Inlet near Daytona and Sebastian Inlet nearly 100 miles to the south. The flow in the canal is mostly influenced by winds. Tidal action within the Indian River Lagoon only affects two to three miles either side of inlets. The speed throughout the entire canal is restricted to "slow speed" and transit time through the canal is approximately 1 hour.

Due to its location, depth and protection the barge canal is well suited for marinas and boat storage areas. The south side of the Barge Canal is developed whereas the north side is mostly undeveloped at this time. At the present time there is a large marina and boat storage area near the east end of the canal (Harbortown Marina, formally Abby's Marina), Harbor Square Marina in a cove on the west end of the canal

and Tingley's fish camp (now closed) at the SR 3 bridge. Tingley's had been operating since the 1960s and closed in 2005. Tingley's had a small boat launching ramp, there are now no boat launching ramps within the barge canal, although very small boats can be launched from the shore at the east end of the canal at the northern end of Banana River drive. The nearest adequate boat ramp is Kelly Park on the Banana River Lagoon in Merritt Island.

Manufacturing along the Barge Canal includes, boat repair at the marinas and Sea Ray Boat manufacturing located on the east side of SR 3 (Courtney Parkway). Sea Ray manufactures fiberglass boats at their facilities along the Barge Canal. Merritt Island is the common name of the overall complex, which includes three plants, Sykes Creek, P.D.&E. (Product Development and Engineering) and the Merritt Island plant. The Sykes Creek plant manufactures yachts from 50 to 63 feet and the Merritt Island plant manufactures yachts from 33 to 40 feet. The P.D.&E. plant is engaged in product development and engineering of the yachts. Approximately 1100 employees work at these facilities although recent layoffs have occurred. This complex has access to the Barge Canal by several boat docks along the south bank of the Canal. Sea Ray tests their boats in the Barge Canal as well as the Lagoons and the Atlantic Ocean. Sea Ray also has another facility on the east end of the canal adjacent to Harbortown Marina. This facility has a boat basin, several docks and direct access to the Barge Canal. It is not open for business at this time.

As a man made access canal, the Canaveral Barge Canal must be maintained to its desired depth through routine maintenance dredging. This is conducted by the U.S. Army Corps of Engineers. The Canaveral Port Authority (CPA) maintains control and ownership of most of the land adjoining the Barge Canal and has lease agreements with various tenants along the canal. Regarding the physical characteristics of the Barge Canal, the entire canal is a straight box cut structure from the Indian River Lagoon to the Banana River Lagoon. Several canals empty into the Barge Canal from the north near station 2 and Station 6. From the eastern, Banana River Lagoon confluence to SR 3, the banks are low with shore line vegetation consisting mostly of Brazilian peppers with some mangroves. There are very little sea grasses areas except at the confluence with the south end of Sykes Creek. From SR 3 to the western confluence with the Indian River Lagoon, the banks on the north and south sides of the canal are steeper and are subject to erosion. There is sparse vegetation along this area until the canal approaches the Indian River Lagoon.

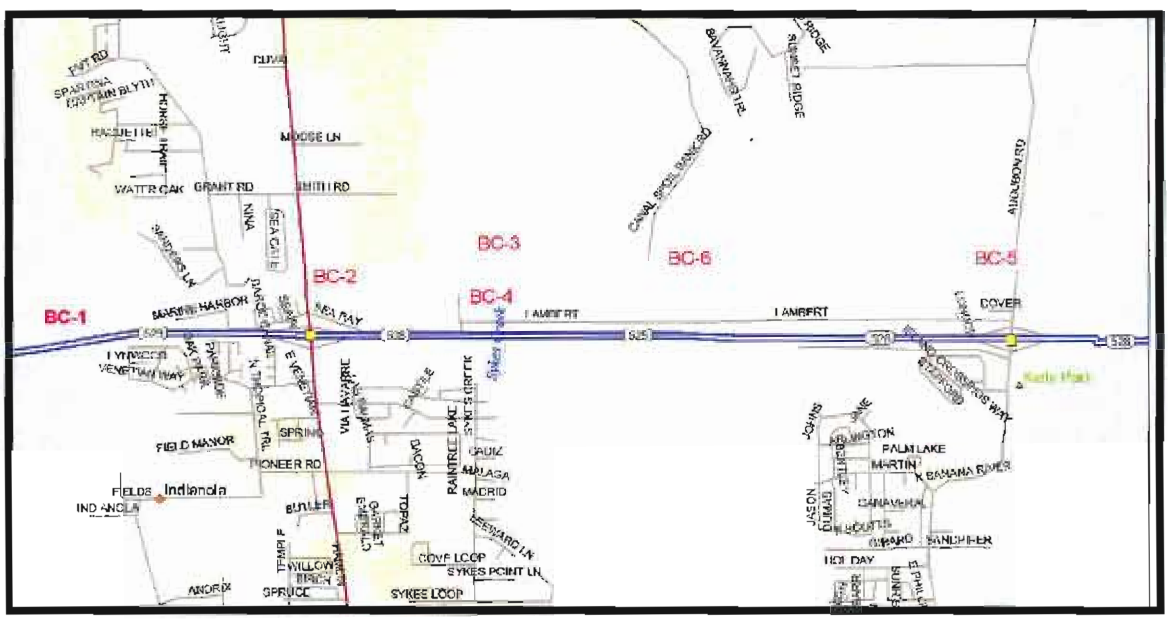
Canaveral Barge Canal Water Quality Stations 2009

Sample locations for the monitoring programs were the same as those used by Sheffield Engineering from 1992-2002 with the exception of a station added in the canal between Sykes Creek and Harbortown. Four stations are located in the canal and a station is located in the north and south confluence with Sykes Creek.

CANAVERAL BARGE CANAL STATION LOCATIONS

BC-1	Canaveral Barge Canal west end at the confluence with the Indian River Lagoon
BC-2	Canaveral Barge Canal just east of SR 3 bridge
BC-3	Sykes Creek north side of Canaveral Barge Canal
BC-4	Sykes Creek just north of the SR 528 Bridge
BC-5	Canaveral Barge Canal east end at the confluence with the Banana River Lagoon
BC-6	Canaveral Barge Canal 100 feet west of Harbortown Marina (Since 2003)

Sample Locations - Discussions

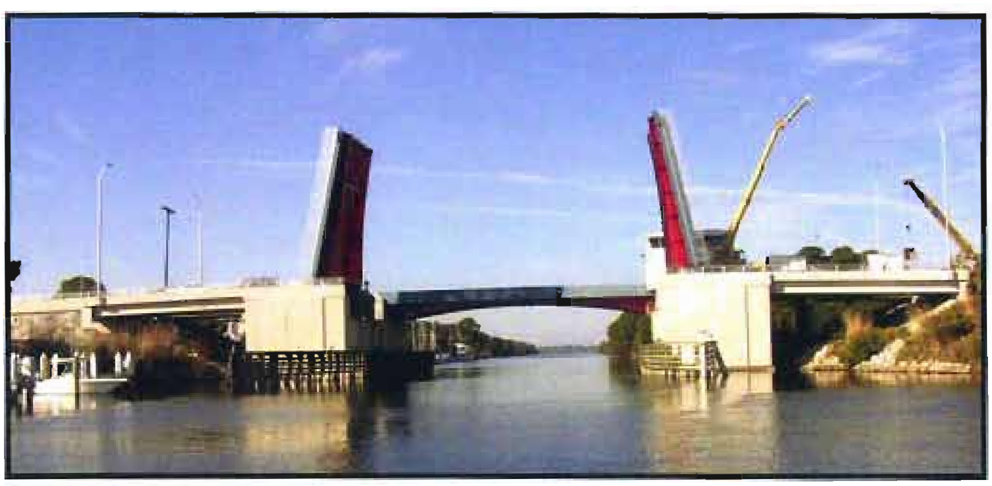


BC-1

just east of the confluence with the Indian River Lagoon. State Road 528 runs along the south side of the canal. Stormwater runoff occurs during rain events. The shoreline has scattered Mangroves and considerable numbers of Brazilian Peppers. The water throughout the barge canal can be described as brackish. High sand banks are on the north and south sides of the canal and are subject to erosion. There is a cemetery on the south shore. Other than that, there is no development near this station. The water depth at this site is 12 feet.

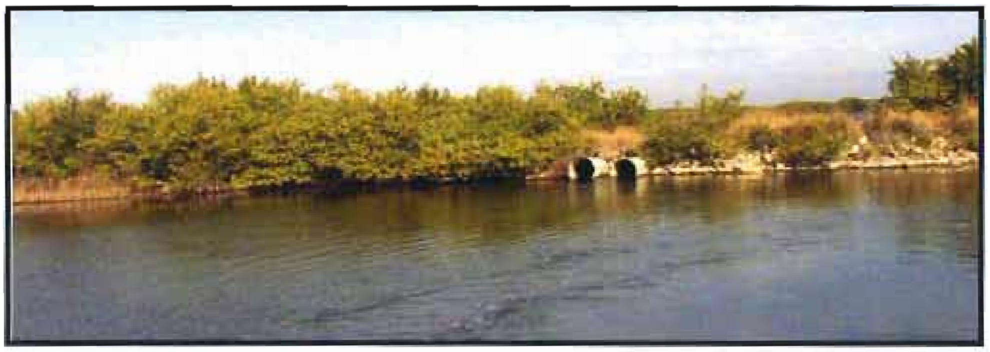
BC-2

just east of the SR 3, Courtney Parkway draw bridge. It is just north of the Sea Ray boat docks. Tingley's Marina (which is now closed) and Harbor Square Marina are just west of the bridge. Harbor Square has occasional and permanent "live aboards". Sea Ray Boat is a boat building factory, using fiberglass, resins and assorted solvents. The south side of the canal is heavily developed where the north side is mostly undeveloped. There is a large water control canal just east of this station on the north side of the canal. The water depth at this site is 15 feet.



BC-3

in Sykes Creek on the north side of the Barge Canal. Sykes creek is bisected by the Barge Canal and the flow from north to south is accomplished by several sets of culverts. The exchange of water is dependent on the rainfall as much of the north side of Sykes creek is used for storm water control. The samples at this site are collected just below the surface.



BC-4

is in Sykes Creek South of the Barge Canal, just north of the SR 528 Bridge. Sykes Creek is heavily developed with residential housing. The creek joins the Banana River lagoon South of SR 520 by way of Newfound Harbor. Historically Sykes Creek has received discharges from three County wastewater treatment facilities. The discharges from these three plants have been removed for over ten years and it is hoped that the water quality will continue to improve. Major concerns in the Sykes Creek area is an increased amount of stormwater runoff from streets and residences along the numerous dead end canals connected to the creek. The sample depth at this site is 9 feet.

BC-5

North Side

In the Barge Canal at the confluence with the Banana River Lagoon. The site is just to the north of the end of South Banana River Drive. There is a dirt parking area where people fish and launch small fishing boats from the shore. From this site eastward is a dredged channel eastward to the Canaveral Locks. This channel is subjected to shoaling and must be regularly maintained. The northern shore of the canal is undeveloped. Beyel Brothers has a storage area on the south side of the canal. The water depth at this site is 15 feet.

South Side

BC-6

a new station created in January, 2003. It is located in the Barge Canal between 100 yards west of Harbortown marina and 100 yards east of the confluence with Sykes Creek. There is a drainage canal entering the Barge Canal from the north near this station. Neither side of the Barge Canal is developed near this station and the nearest influence is Harbortown Marina to the east. The water depth at this site is 15 feet.

Harbortown Marina

Water Quality Sampling

Sampling of all the stations was conducted in the morning to the early afternoon. At each station the depth was determined by a fathometer on the sample vessel. The Secchi depth was taken with a Secchi disc. Field measurements were profiled at 1 foot from the surface, mid depth and 1 foot from the bottom. Field measurements were Temperature, pH, conductivity, Dissolved Oxygen and Salinity. General Chemistry (grab) samples were collected at mid depth, chlorophyll samples were collected at mid Secchi depth. Fecal coliform, total coliform and oil & grease samples were collected at the surface.

Samples were collected on a monthly basis by SEAS personnel. Samples were collected in sample bottles provided by the contract chemistry laboratory, Test America. These sample bottles contained the appropriate preservatives. Sampling times, locations and field measurements were recorded on a field data sheet developed by SEAS. Samples were maintained in the custody of SEAS field personnel until transferred to Test America Laboratories. Field/laboratory chain of custody was employed and documented. Metals Samples are collected quarterly and analyzed by E-Lab in Ormond Beach, Florida.

Field Sampling Equipment

All field measurements were acquired using a Hydrolab Quanta multi meter. This instrument is owned, operated, calibrated and maintained by SEAS.

Prior to each field sampling event, the multimeter was calibrated by SEAS personnel. Calibration was conducted for each parameter as per the manufacturer's recommendation. Calibration is documented on a calibration log identical to that used by Florida DEP. Following each sampling event, the meter is post calibrated and that data is logged for quality purposes. The meter is cleaned and maintained as needed following each sampling. The meter is also checked by a factory trained Hydrolab professional as needed.

Water samples are collected at depths using a Van Dorn type water sampler. The sampler is cleaned and maintained by SEAS associates. Surface samples are hand dipped.

Training

SEAS associates are trained and experienced in the collection of surface water quality samples. Guy Hadley, SEAS Principal Environmental Scientist, has trained all SEAS personnel. SEAS has adopted and follows the Department of Environmental Protection's Standard Operating Procedures Manual (DEP-SOP-001/01). The formal and hands on training of all personnel include training on all sections of the DEP SOP including: documentation (FD), field planning (FM), field quality control requirement (FQ), aqueous sampling (FS), and field-testing and measurement (FT).

SEAS also uses the Standard Operating Procedures Manual for Biology and Field Sampling Programs; written for DEP in 1988 by Guy Hadley and Louis Ley. This manual includes sections on; care, maintenance and calibration of field equipment and meters, field safety, field measurements, sample preservation, data documentation as well as the use of sophisticated field sampling devices.

SAMPLE COLLECTION PROCEDURES

All samples were collected using approved methods set forth in the FDEP standard operating procedure manual. All sample preservation procedures, container materials, and maximum holding times for the parameters conform to the EPA requirements set forth in 40 CFR 136.3 Table II. All sampling equipment is maintained in an uncontaminated state at all times during the sampling. Laboratory and field calibration of field instruments is conducted and documented as required.

As each sample was collected it was placed in an ice chest and cooled to 4 degrees Centigrade. This condition is maintained until samples are returned to the laboratory. All samples are analyzed within the holding times prescribed by the USEPA.

DISCUSSION OF WATER QUALITY SAMPLING PARAMETERS & RESULTS

PARAMETER	UNIT OF MEASUREMENT
Water temperature	degrees C
Dissolved Oxygen	mg/L (milligrams per Liter)
Salinity	$^0/_{00}$ Parts per thousand
Specific Conductance	µmhos/cm
pH	Standard Units
Secchi Depth	Meters
Water Depth	Feet

Parameters of Samples collected monthly

Biochemical Oxygen Demand	mg/L
Turbidity	NTU (nephelometric turbidity units)
Total Suspended Solids	mg/L
Total Kjeldahl Nitrogen (TKN)	mg/L
Nitrites + Nitrates (NO_2 + NO_3)	mg/L
Total Nitrogen (TN)	mg/L
Total Phosphorus (TP)	mg/L
Chlorophyll a (CPA)	(ppb) mg/M^3
Fecal Coliform (FC)	cfu/100ml
Total Coliform (TC)	cfu/100ml

Additional Parameters of Samples collected quarterly

Total Organic Carbon	mg/L
Oil & Grease	mg/L
Aluminum	mg/L
Copper	ug/L (micrograms per Liter)
Iron	mg/L
Lead	ug/L
Mercury	ug/L
Zinc	ug/L

Additional Parameters of Samples collected annually

Cadmium	ug/L
Chromium (hexavalent)	ug/L

State Water Quality Standards for metals Oil & Grease and PAH

Aluminum	-	1.5 mg/L (milligrams per liter)
Copper	-	3.7 ug/L (micrograms per liter)
Iron	-	0.3 mg/L (milligrams per liter)
Lead	-	8.5 ug/L (micrograms per liter)
Mercury	-	0.025 ug/L (micrograms per liter)
Sine	-	86.00 ug/L (micrograms per liter)
Oil & Grease *(hexane extraction)*	-	5.00 mg/L (milligrams per liter)
Cadmium	-	8.8 ug/L (micrograms per liter)
Chromium (hexavalent)	-	50.0 ug/L (micrograms per liter)

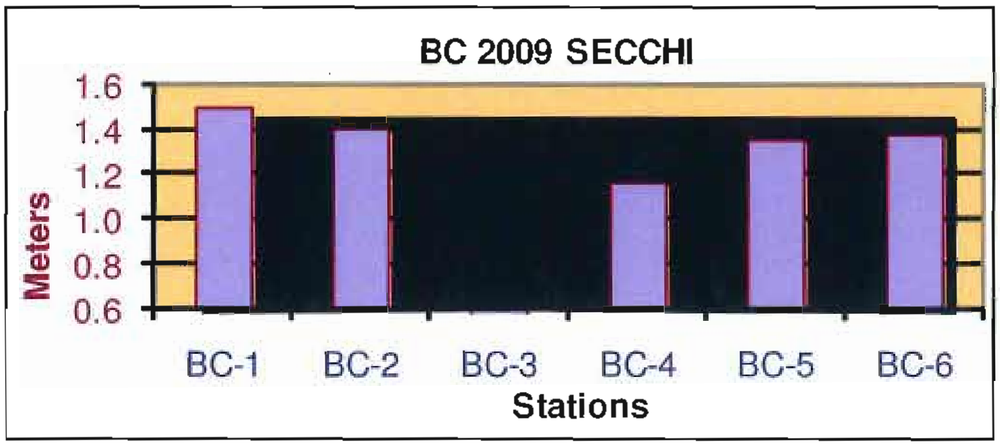
Water Temperature

Temperature is one of the more important parameters to be considered when examining water quality. Many biological, physical and chemical parameters are dependent on temperature which can dramatically affect the rates of chemical and biological reactions. Some of the more common things which temperature can have an effect upon are: solubility of chemical compounds in water; distribution and abundance of organisms; rate of growth of biological organisms; water density; mixing of water of different densities and current movements. The amount of oxygen that can dissolve in water is dependent upon temperature. The solubility of oxygen decreases as the temperature of the water increases. Temperature, specific gravity and salinity are also intimately interrelated. For a body of water of given salinity, as the temperature of the water decreases, the specific gravity will increase and the water becomes more dense. Conversely, as the water warms up, the water will expand and the specific gravity will decrease.

Temperatures in the Barge Canal were consistent with previous years with the values changing seasonally. Water temperature during the summer months averaged 29-30 degrees Centigrade (over 85 degrees Fahrenheit).

Secchi Depth

The Secchi Depth is a method for measuring the penetration of light below the surface of the water and thus the limit of visibility of the water. The method uses a Secchi Disk with four alternating black and white painted quadrants (quarters) with a premeasured line attached. The disk is lowered into the water until it can no longer be seen by an observer at the surface or the black can no longer be distinguished from the white areas. This depth is known as the Secchi Depth. Low Secchi Depths usually are caused by large amounts of suspended material or natural or man-made chemicals dyeing the water a dark color. Large concentrations of algae, especially algae blooms caused by excess nutrients will also lower the Secchi Depth. Low Secchi Depths mean that sunlight will not penetrate far below the surface of the water. If light levels become too low, plants which live on the bottom, like sea grasses, may not be able to photosynthesize and will die.



Secchi depths are consistent with Estuaries state wide with all station values of one meter throughout the year. Secchi depths were slightly higher than the last year.

pH

Measurement of pH is one of the most important and frequently used tests in water chemistry. This test gives you an indication of the intensity of the acidic or basic characteristic of a solution. pH is a measure of the hydrogen ion activity of a solution.

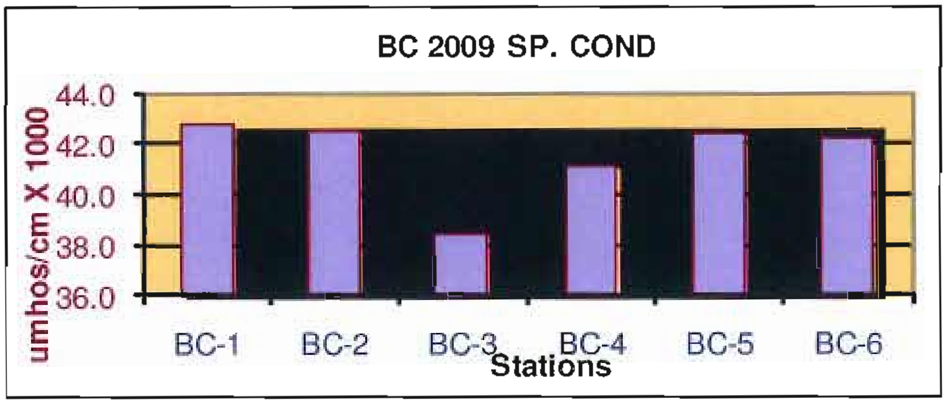
The buffering capacity of water or its ability to resist changes in pH is critical to aquatic life. The ability of aquatic organisms to survive greatly diminishes as the pH falls below 5 or increases above 9. Fluctuations in pH can also have adverse affects on other organisms. As the pH decreases to 6 or less, reductions in species numbers can occur and the ability to reproduce can be adversely affected. When the pH drops to 5 or less, species numbers and diversity will be significantly reduced with some species of fish suffering large mortalities. Below a pH of 4, most species of fish are totally eliminated.

pH is measured with a meter. The pH probe has a membrane permeable by H ions and the resulting change in current is read on a scale as pH units. For correct measurement, meters must be frequently and properly calibrated. Measurements for pH are taken in situ. pH can be measured to 0.01 pH units, but normally 0.1 pH units are accurate enough for environmental concerns. The pH measurement is logarithmic so a change of 1 pH unit is a 10 fold change in the concentration of H^+ ions.

pH values throughout the Barge Canal were between 7.4 and 8.4 and averaged 8.0 in 2009.

Conductivity

Conductivity is a measurement of an aqueous solution's ability to carry an electrical current and is used as a rapid estimate of the dissolved ionized particles in a sample. It must be remembered that this is an estimate only. Conductivity usually gives you an idea of the ionized salt content of a sample. The higher the conductivity, the higher the salt content. Conductivity is measured with a conductivity meter and is temperature dependent. All conductivity readings should be corrected to 25 degrees Celsius.

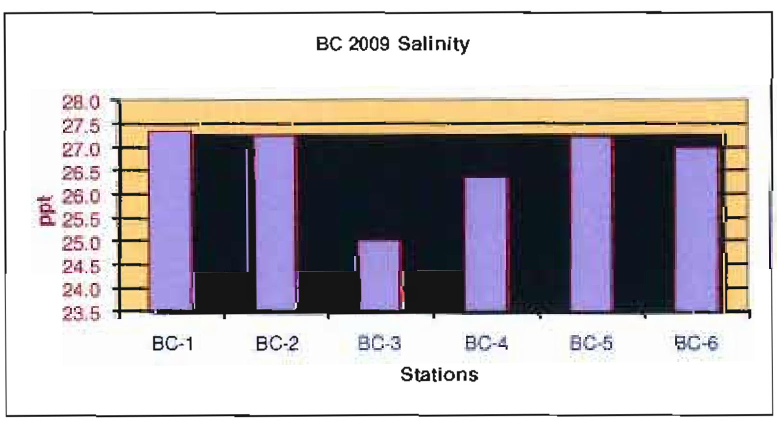


Conductivity values this year were again slightly higher than in previous years and averaged between 38,500 and 42,800 umhos/cm.

Salinity

Salinity is the concentration of salt dissolved in water. It is normally expressed in parts per thousand or the grams of salt per 1000 grams of water sample (ppt, $^0/_{00}$). In a water body influenced by the ocean, such as the Indian River Lagoon, most of the dissolved salt in the water is due to only a handful of sea salt components. Most of Port Canaveral, being sea water, has salinities near 35 parts per thousand. Salinity in the Barge Canal varies depending on the fresh water influences to the system.

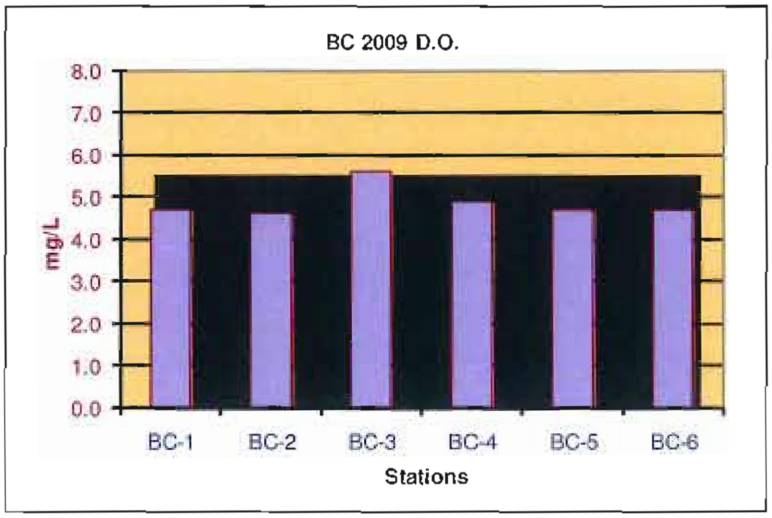
Salinity and Conductivity are closely related. In fact the Salinity read on a meter is an electronic calculation of the conductivity and temperature readings. Sea water will have high salinity and high conductivity.



The Barge Canal has typical estuarine salinity with averages nearly identical to last year; between 25 and 27.3.

Dissolved Oxygen

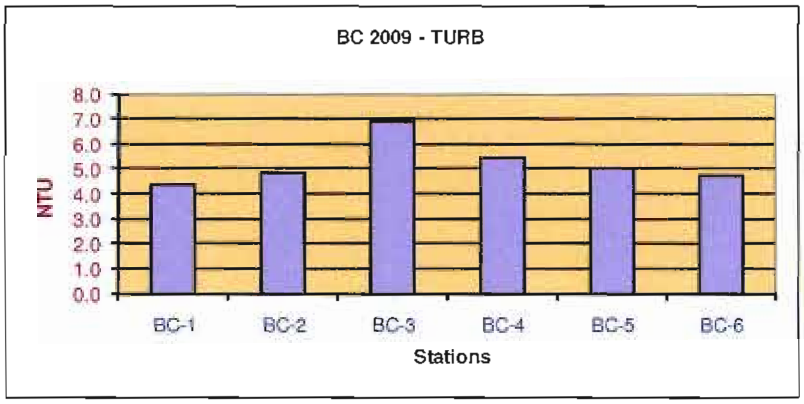
Dissolved Oxygen (DO) violations (less than 4 parts per million) were found at all stations in the summer months between May and September. Average values were lower than last year and ranged between 4.6 and 5.6 ppm. It is not unusual for DO to be depleted during the summer months in Florida estuaries.



Turbidity

Turbidity measures the visual clarity of a water sample and often indicates the presence of fine suspended particulate matter. Turbidity is a measurement of the optical property which causes light to be scattered and absorbed rather than transmitted in a straight line.

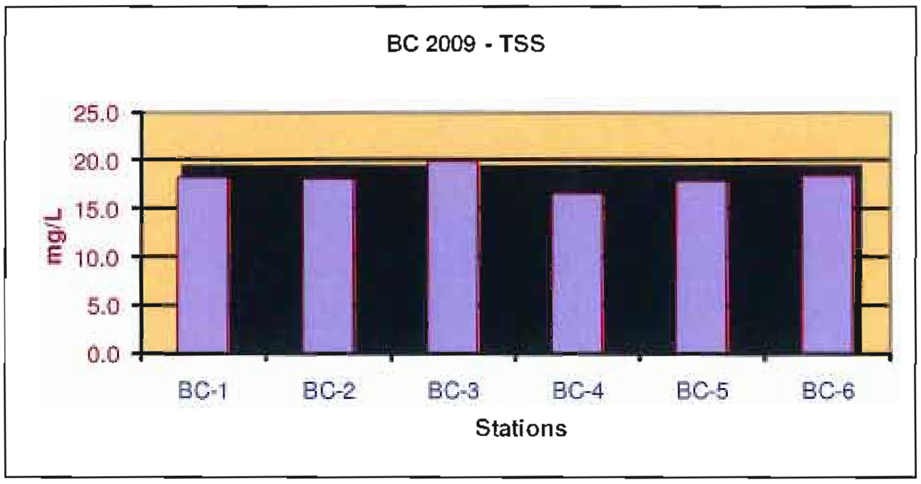
The unit used to measure turbidity is NTU (nephelometric turbidity units). Because particles can have a wide variety of sizes, shapes and densities, there is no direct relationship between the turbidity of a sample and the concentration of the particulate matter present. This is why we test for NTU turbidity as well as for Total suspended solids. The Florida State standard for Class III Marine waters states that the turbidity can not exceed more than 29 NTUs above background.



No turbidity violations were documented in the 2009 sampling. Values were slightly less than in 2008. High measurements were again experienced at station 3 which is the north side of Sykes Creek. These higher values are probably due to the storm water runoff from the north.

Total Suspended Solids

The measurement of total suspended solids (TSS) consists of a dry weight determination of the particulates in the water column. Both organic and inorganic materials contribute to TSS in water. The effects from increased TSS are basically the same as those associated with turbidity. Suspended solids can affect the aquatic environment and its organisms by damaging macroinvertebrate communities through the processes of deposition. The deposition of organic matter can also remove dissolved oxygen from the overlying water. A major source of TSS, and thus turbidity, in natural waters is runoff from urban and commercial areas. There is no numeric standard for total suspended solids in Florida.

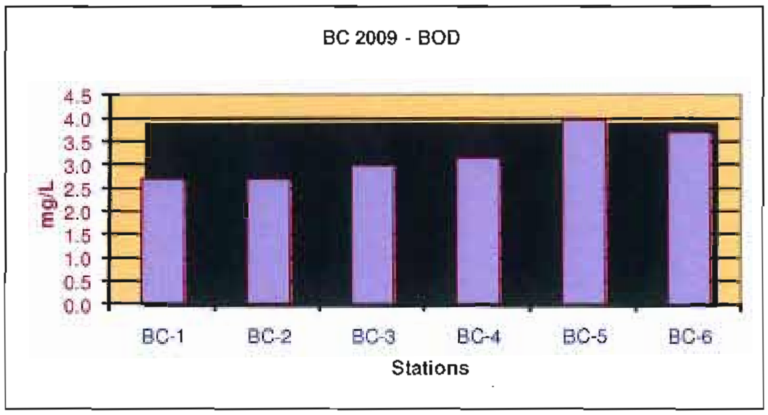


Although average Total Suspended Solids values were not as high as measured in 2007 where they averaged from 23.6 to 28.7 mg/L. there has been a steady increase since 2004 when the values averaged from 10 to 14 mg/l. This year the averages were between 16.5 and 19.9 ppm and all stations reported TSS values above 20 ppm with some measurements exceeding 30 ppm during the year Although high TSS values are not uncommon for estuaries state wide, the steady yearly increase of TSS indicates an upward trend and it, along with turbidity, should be watched very closely in the future.

Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand (BOD) is a measurement of the quantity of dissolved oxygen required by microbial organisms to decompose organic matter which occurs naturally or is generated by human activities. The biochemical oxygen demand test was initially designed for use in determining engineering criteria for municipal and industrial plants which discharge to surface waters. It is also helpful in calculating the assimilative capacity of the receiving body of water. High biochemical oxygen demand is a major contributor to dissolved oxygen depletion and is normally indicative of poor water quality. A low BOD generally indicates good water quality.

The standard for a BOD analysis is the 5 day BOD. BOD may be analyzed for longer than this however. A long term BOD may tell the ultimate oxygen demand of the sample. There is no standard for BOD however it can be tied to the DO standard of 4 mg/l in marine waters.

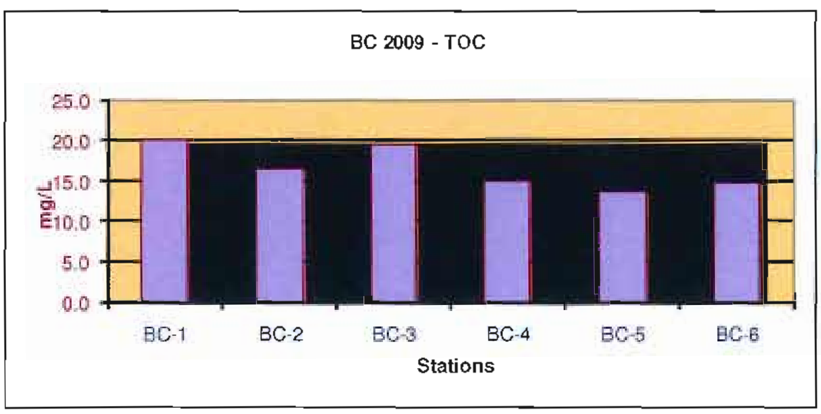


Average BOD5 values increased this year. Last year the averages were between 2.3 and 3.5. This year the average was between 2.7 and 4.0. High BODs seem to be an ongoing problem for the Barge Canal. This parameter needs to be watched closely in the future.

Total Organic Carbon

Total organic carbon (TOC) is a measure of the total amount of the decayed, natural, organic material in a water sample. Levels less than 5 mg/L generally indicate reasonably good quality water sources. Levels above 10 mg/L indicate water that is difficult to treat, will require high chemical doses, and will likely produce disinfection byproducts when chlorine is added. Most TOC in water is naturally occurring material from the decomposition of vegetation and soil matter; however, it may also contain small amounts of oil and gas, industrial solvents, or pesticides.

The results of TOC analysis like the BOD analysis are useful in assessing the potential amount of oxygen demanding organic matter present in a body of water. Combined with information pertaining to nutrients, TOC analysis is one of the conventional measures of eutrophication.



Total Organic Carbon values were found to be much higher than previous years. Last year, for the first time values averaged above the statewide average of 6.1 ppm at all stations. Values were beginning to increase in 2006. The 2008 average TOC was more than twice that of previous years. This year also found TOC values high; averaging between 13.7 and 20 ppm. This parameter, like BOD may signal an increasing trend in oxygen demand within the Barge Canal.

Nutrients

The Nutrients, Nitrogen and Phosphorus are a primary concern when evaluating water quality. Although nitrogen and phosphorus are essential nutrients and required to maintain a healthy aquatic community, excess nutrients in surface waters can cause an imbalance of the flora which may result in algae blooms.

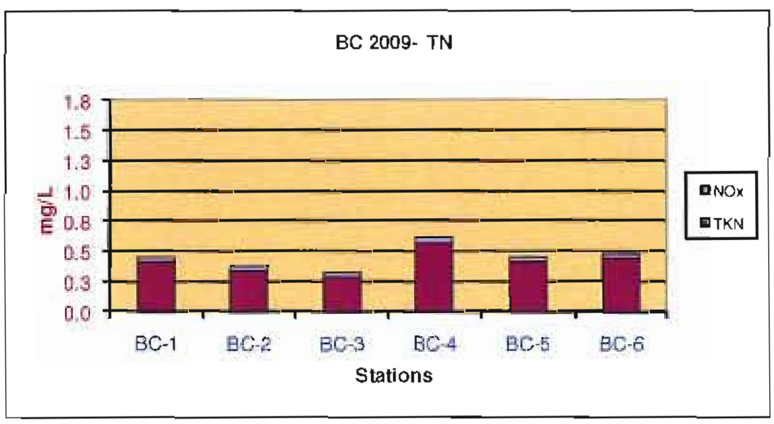
Nitrogen

Total nitrogen (TN) is the combined measurement of nitrate, nitrite, ammonia and organic nitrogen found in water. Nitrogen compounds function as important nutrients to many aquatic organisms and are essential constituents in the dynamic chemical process.

The major source of excessive amounts of nitrogen in surface water is the effluent from municipal treatment plants and runoff. When the concentration of nutrients consistently exceed natural levels, a nutrient imbalance is produced, which can cause undesirable changes in the biological community. This imbalance can drive an aquatic system into an accelerated rate of nitrogen enrichment. Usually, this enrichment process is seen as an increase in the chlorophyll values and may result in algae blooms. Algae blooms may be followed by a decrease in dissolved oxygen concentrations.

When highly organic pollution is introduced to the water, the Ammonia and the Organic nitrogen (TKN) will be increased and the inorganic Nitrites and Nitrates (NOx) will generally be lower. As oxidation takes place, the TKN will be converted to Nitrites (NO2) and the rapidly to Nitrates (NO3). This process may also lower the oxygen in the water column.

There is not a numeric standard for Nitrogen in Florida; however, it must not be increased so as to cause an imbalance in the flora or fauna. When total Nitrogen values are over 1.0 mg/l in waters that are normally clean, a source of organic pollution is suspected.



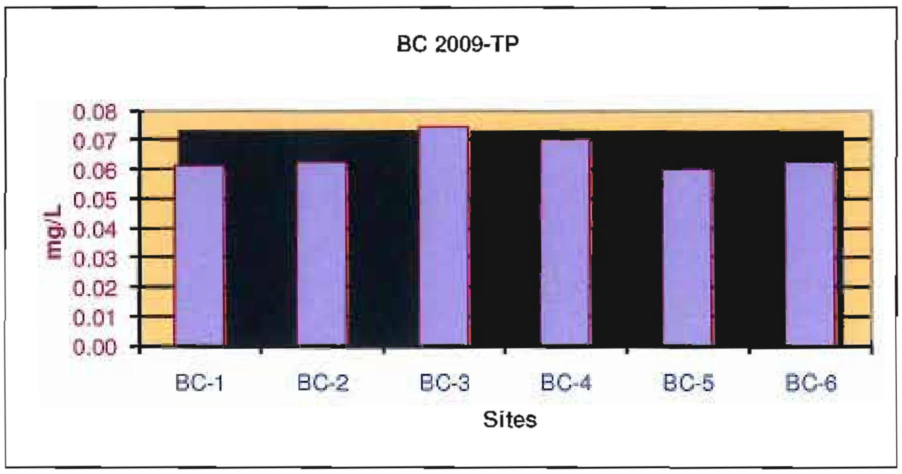
Total Nitrogen values were very low throughout the Barge Canal in 2009. In the past, values of over 1.0 have been considered sufficient to cause an imbalance in the flora in estuaries (algae blooms). In the TMDL report published by DEP this year the suggested value for the Lagoon and tributaries is 0.98 based on a 12 month median and 1.0 based on 18 month median.. The averages for the barge canal averaged from 0.26 and 0.61 this year. That being said, the Chlorophyl_a values have increased again this year and since nitrogen is normally the limiting nutrient for estuarine waters it warrants watching in the future.*

Phosphorus

Phosphorus is one of the primary nutrients that regulates algae and macrophyte growth in natural waters, particularly in fresh water whereas nitrogen is usually the limiting nutrient in marine waters. Phosphate, the form in which almost all phosphorus is found in the water column, can enter the aquatic environment in a number of ways. Natural processes transport phosphate to water through atmospheric deposition, groundwater percolation, and terrestrial runoff.

High phosphorus concentrations are frequently responsible for accelerating the process of nutrient enrichment. Once phosphorus and the other important nutrients enter the ecosystem they are extremely difficult to remove. These nutrients become entwined in the system, either tied up in the biomass or deposited in the sediments. Nutrients, particularly phosphates, deposited in the sediments generally undergo redistribution to the water column. This type of cycling of nutrients accelerates the nutrient enrichment process.

There is not a numeric standard for phosphate in Florida; however it must not be increased so as to cause an imbalance in the flora or fauna. When total phosphate values are over 0.1 mg/l in waters that are normally clean, a source of organic pollution is suspected. Normally coastal waters have Phosphate levels between 0.05 and 0.13 mg/l.



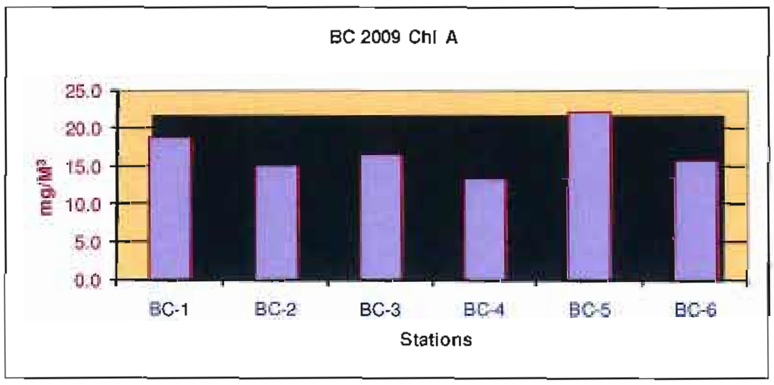
Like nitrogen, the phosphorus values in the barge canal were low in 2009. The exception is the north Sykes creek station (station3). Like Nitrogen, there is not a numeric standard for phosphorus. In the past we have used 0.1 ppm or lower for an indication of acceptable levels of phosphorus. The 2009 DEP TMDL report sets the 12 month median value oat 0.05 ppm and the 18 month median at 0.06 ppm. The recorded averages in 2009 were between .06 and .07 ppm. Although the limiting nutrient in estuarine systems is normally nitrogen, the phosphorus values should also be watched closely.*

**NOTE: TMDLs for the Banana River Lagoon segments are developed based on the correlation between watershed loadings and seagrass depth limits.*

Chlorophyll-a

Chlorophyll is a green pigment found in plants and is an essential component in the process of converting light energy into chemical energy. There are several types of chlorophyll; however, the predominant form is chlorophyll *a*. The measurement of chlorophyll *a* in a water sample is a useful indicator of phytoplankton biomass, especially when used in conjunction with analysis concerning algae growth potential and species abundance.

Chlorophyll *a* measurements are also used to estimate the trophic condition of a waterbody Chlorophyll *a* values ranging from 0 to 25 mg/M^3 are usually considered to be acceptable values. Chlorophyll *a* values over 25 for any amount of time are usually an indication of nutrient enrichment and a nutrient source should be sought. These designations are useful only as a general guide, except when used in conjunction with other biological and water chemistry data. (See TMDL)



There has been an upward trend in Chlorophyl_a values in the Barge Canal since 2004. In 2008 the averages ranged from 13.3 go 22.1 mg/M3 (ppb). This year the Chl-a averages were between 13.3 and 22.1. The values measured from July through October of 2009 were extremely high reaching as high as 80 ppb. The 2009 TMDL report suggest values exceeding 11 ppb or chlorophyll_a values increased by more than 50% over historical values for at least two consecutive years indicate impaired waters.

Total Maximum Daily Limit (TMDL)

In March of 2009 the Florida Department of Environmental Protection (DEP) published a TMDL report "Nutrient and Dissolved Oxygen TMDL's for the Indian River Lagoon and the Banana River Lagoon". The Canaveral Barge Canal is part of three water assessment polygons with waterbody identification numbers 3057B (Banana River above 520 Causeway), 3057C (Banana River above Barge Canal), and 2963D (Indian River above 520 Causeway. The TMDL takes into consideration Total nitrogen, Total phosphorus and Chlorophyll_a . The following is a brief summary and excerpts from the report and the TMDL program as it pertains to the areas in the vicinity of the Canaveral Barge Canal. The entire document is available on the DEP website http://www.dep.state.fl.us/.

Total Maximum Daily Limit (TMDL)- Continued

A Total Maximum Daily Limit (TMDL) represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet water quality standards, including its applicable water quality criteria and its designated uses. TMDLs are developed for waterbodies that are verified as not meeting their water quality standards, and provide important water quality restoration goals that will guide restoration activities. The U.S. Environmental Protection Agency (EPA) finalized a nutrient and DO TMDL report for the Indian River Lagoon (IRL) and Banana River Lagoon in 2007. The report addressed the lagoon segments that were on the EPA's 1998 303(d) list of impaired waters, which only covers portions of the main stems of the IRL and Banana River Lagoon. The EPA report also covers the nutrient and DO impairments in several tributaries that discharge into the IRL, and was based on the nutrient targets developed to protect seagrass communities in the main stems of these lagoon systems. In contrast, the nutrient and DO TMDLs in this TMDL report address only the nutrient and DO impairments for the main stems of the IRL and Banana River Lagoon. No tributaries are included because the Department believes that the nutrient targets for protecting the tributaries may be different from those established for protecting the main stem segments. Therefore, the Department of Environmental Protection will publish tributary nutrient and DO TMDLs in a separate report in the near future. In addition, because the entire main stem of the Banana River Lagoon and all the IRL main stem segments north of the southern boundary of Indian River County were listed as impaired for nutrients on the Department's Verified List, this TMDL report covers all these main stem segments, instead of just those on the EPA's 1998 303(d) list. The implementation of the TMDLs will apply to the watershed that drains to all these lagoon segments.

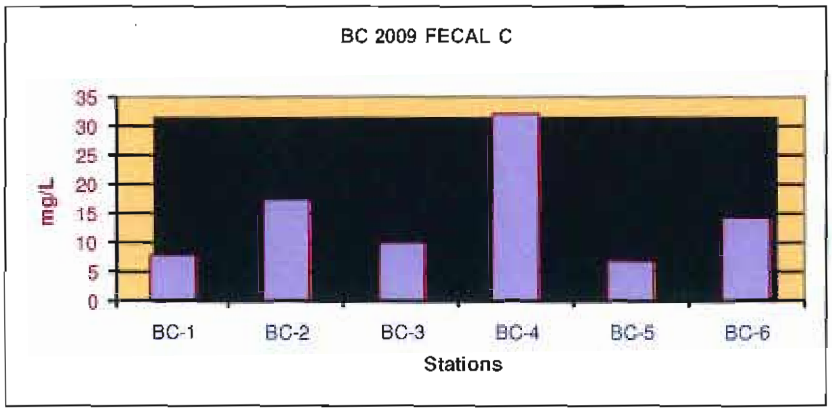
62-303.353 Florida Administrative Code Nutrients in Estuaries and Open Coastal Waters states:
"Estuaries, estuary segments, or open coastal waters shall be included on the planning list for nutrients if their annual mean chlorophyll a for any year is greater than 11 ug/l or if data indicate annual mean chlorophyll a values have increased by more than 50% over historical values for at least two consecutive years."
Specific Authority 403.061, 403.067 FS. Law Implemented 403.062, 403.067 FS. History - New 6-10-02,

TMDLs for the IRL and Banana River Lagoon segments covered in this report are developed based on the correlation between watershed loading and seagrass depth limit. Nutrient targets are developed as loading targets. No nutrient concentration targets are explicitly developed in this TMDL, although the per-acre nutrient loadings from the watershed imply the nutrient concentrations from the watershed. The SJRWMD is currently working on defining concentration targets for the estuarine segments of the IRL. These targets include TN and TP, as well as other parameters, and are being developed from the median concentrations observed where seagrass depth limits are within the -10 percent departure (shoreward) from their full-restoration levels. The project is still in progress, but it suggests TN concentrations of 0.98 mg/L based on 12-month medians, or 1.0 mg/L based on 18-month medians. For TP, the 12-month median is 0.05 mg/L, and the 18-month median is 0.06 mg/L (Steward and Green 2006). Having target nutrient concentrations for these waters can facilitate evaluating the effectiveness of nutrient removal in the watershed, because it is easier to measure nutrient concentrations than to directly measure the nutrient loadings from the watershed. In addition to directly measuring the TN and TP concentrations in the lagoon segments that have already achieved seagrass depth limits, studies on the processes that influence nutrient dynamics in these lagoon segments will be instrumental in interpreting nutrient concentrations in these waters. For example, if a low nutrient concentration is observed, it is important to understand whether it means a high uptake rate from periphyton or low nutrient watershed loading.

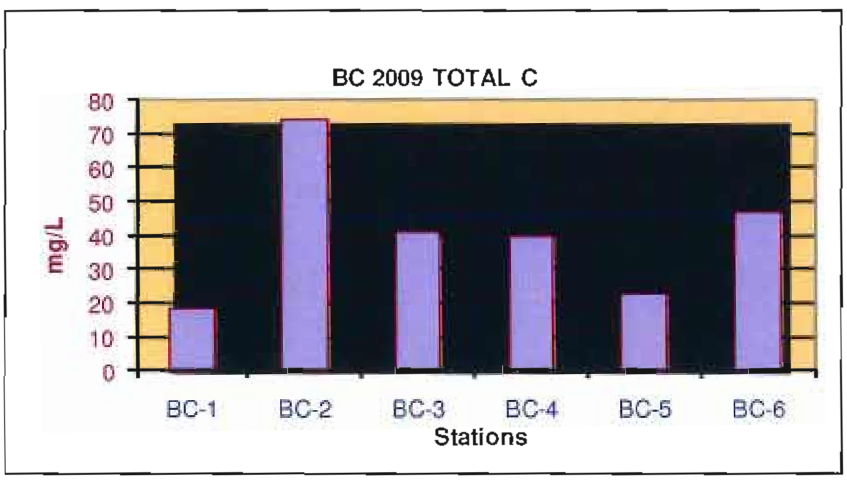
Total and Fecal Coliform

The presence of Coliform bacteria are indicators of fecal contamination in surfaces waters. Total coliform bacteria are a collection of relatively harmless microorganisms that live in large numbers in the intestines of man and warm and cold blooded animals.

The **fecal coliform** procedure is a method used to determine the presence of fecal coliform bacteria in the water column. The predominant species in the fecal coliform group is *Escherichia coli,* a species indicative of fecal coliform pollution (and possibly the presence of pathogens). The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water.



Total coliform measurements are commonly used to determine when shellfish harvesting can safely occur and whether or not swimming areas are indeed safe for swimming.

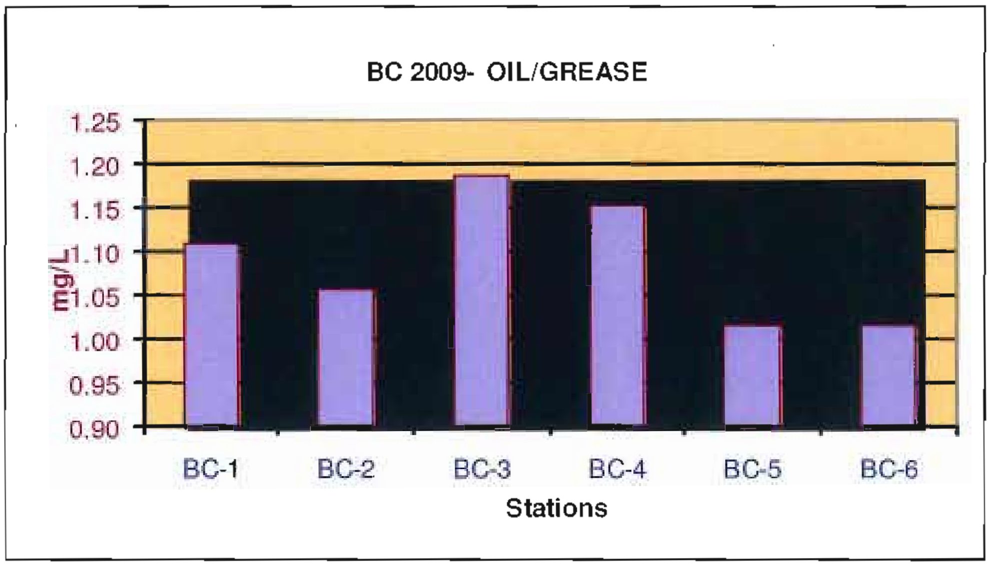


There were no violations of Fecal Coliform in the Barge Canal in 2009. In 2006 the Florida Water quality standard for Total Coliform was removed from 62-302 and the standard for Fecal Coliform remains the same. The State average for Florida estuaries is 15 colonies per 100 ml for fecal coliform. In 2008 there were some higher than normal values measured especially at the north Sykes Creek Station. Fecal coliform averages ranged between 14 and 83 in 2008. This year the FC range was from 7 and 32. The Total Coliform ranged between 23 and 74.

Oil and Grease

The presence of oil and grease in surface waters is a result of man made activities. Oil in the water can come from the operation of outboard motors, the shaft packing from vessels. Discharges from oil/water separators onboard deep draft vessels, oil spills in surface waters, spills from shore side facilities, leaks from vehicles at boat ramps and storm water runoff from roads, parking lots and storm water ponds. The state has set a surface water standard of 5 parts per million oil and grease.

Although most discharges of oil into surface water can be controlled by environmental awareness and public and commercial environmental responsibility, small amounts of oil introduced into the surface waters can have a serious cumulative impact on the canal.



Since 2004 all samples for oil and grease were below the state standard of 5 ppm at all stations. Violations of state standards were documented at station 5 at the confluence with the Banana River Lagoon two out of four samplings and at station 6 near Harbortown Marina in March of 2004. These violations could be attributed to storm water runoff from roads and/or parking areas. This parameter should still be watched closely and sampled more often.

Heavy Metals

Heavy metals are metals with a high atomic weight such as mercury, lead, cadmium, chromium and zinc. Heavy metals have widespread industrial use. They tend to persist in living organisms once consumed and can accumulate in selective organs.

Metals are found naturally occurring in surface waters in minute quantities as a result of chemical weathering and soil leaching. However, concentrations greater than those occurring naturally can be toxic to human and aquatic organisms. Elevated levels may indicate the presence of industrial pollution, wastewater discharge, and urban runoff.

Potential marine sources of heavy-metal pollution include leachates from copper bottom paint on boats in marinas and sacrificial anodes on boats docked at marinas. Sacrificial anodes protect other metals on boats from breakdown by electrolysis.

Statewide analyses indicates that concentrations of silver, copper, lead, and zinc are highest near marinas where water circulation is more restricted allowing longer residence times for the contaminants.

Copper:
The Class III Marine standard of 3.7ug/l has been established to protect aquatic life. In most areas, ambient levels are usually below 1.0 ug/l. Copper may leach into the water from pilings treated with CCA preservatives or anti-fouling paint on boats. Copper is also present in leaded, unleaded, and diesel fuel emissions.

Chromium:
Naturally occurring element. A source of Chromium could also be from CCA treated pilings on piers and docks. The Class III Marine standard of 50 ug/l has been established to protect aquatic life.

Lead:
A Class III Marine standard of 8.5 ug/l has been established to protect aquatic wildlife, while the normal ambient level is usually below 1.0 ug/l. Lead was once common in road runoff from the use of leaded gasoline. Roadside soils still generally contain high lead levels, resulting in elevated surface water concentrations if these soils are subject to erosion.

Zinc:
Zinc is used in coatings to protect iron and steel, in alloys for die casting, in brass, in dry batteries, in roofing and exterior fittings for buildings, and in some printing processes. The principal sources of zinc to aquatic systems include municipal wastewater effluents, waste incineration, and atmospheric emissions. Zinc is a major metal component of tire rubber and brake linings, and galvanized metal. The surface water standard is 86 ug/l. typical ambient levels of zinc are usually low in coastal marine systems, approximately 5.0 ug/l.

Iron:
One of the most abundant metals in the earth's crust. It is found in natural fresh waters at levels ranging from 0.5 to 50 mg/liter. A source of iron in the marine environment can be a result of rusting metals. The Florida State Marine standard for iron is 0.3 mg/l.

Cadmium:
Cadmium is a trace element used in a wide variety of applications, including electroplating, the manufacture of pigments, storage batteries, telephone wires, photographic supplies, glass, ceramics, some biocides, and as a stabilizer in plastics.

A naturally occurring mineral, Cadmium is found in marine waters at low levels. The State standard for Cadmium in marine waters is 8.8 per billion.

Samples analyzed for metals can be affected by the presence of Chlorides. Chlorides can cause false positives for certain metals and care must be taken when presenting these data as they may not be accurate

The presence of metals above the state standards may be a result of runoff from developed areas or leached from the sediment. It is important to evaluate the sediments to determine the sources of metals.

Violations of state standards for mercury were reported at two stations in March. The stations were resampled in May and found to be below the state standard.. All other metals were within the state standards.

DATA APPLICATION AND EVALUATION

When applying or evaluating data, combinations of some parameters can aid in determining how much validity should be given the data. These relationships are generalizations but they can be used to quickly locate potential problems with surface water quality.

A sudden change in any parameter may suggest a source or problem with water quality. The data are like pieces of a puzzle which should mesh together. This is why it is important to look at all parameters together and not to take one parameter and make general decisions as to the quality of the body of water.

Turbidity is caused by suspended matter in the water and TSS is a measure of suspended matter in the water. When the TSS increases, usually the turbidity increases. When the TSS decreases, usually the turbidity decreases. If the turbidity is low, the TSS is low. If the turbidity is high, the TSS usually is high. High values of TSS and turbidity can be caused by rain, wind, algae, or point sources.

When the temperature increases, DO decreases. When temperature decreases, DO increases. If there is an algae bloom, DO may become supersaturated. When there is an algae bloom and the algae begins to die, the DO decreases with the increased demand for oxygen. High BOD will often cause low DO. Trends of increasing oxygen demand are an important parameter to watch closely.

In systems with moderate amounts of algae, nutrient values are affected. In warm months, algae production is high and Chl a values are high. During this time TKN and TP increase and $N0_3$ decreases because it is used by the alga which converts it to TKN. PO_4 increases due to the amount of PO_4 available which is consumed by the algae and the amount which remains soluble. During the colder months, algae production decreases. During this time NO_3 increases because there is less algae demand for it. TKN decreases because algae is not converting as much NO_3. PO_4 decreases because of the decreased demand for PO_4 by the algae. The nutrient of most concern in marine systems in normally nitrogen. An increase of nitrogen is usually necessary to increase algae growth. However, phosphorus values are also an important parameter to watch.

If the common metals (Na, Ca, Mg, Fe, K), also known as cations, and the common anions (Cl, SO_4, CO_3) are analyzed, for there should be a relationship between the two groups. The total cation concentration should be approximately the same as the total anion concentration.